Submission Annex

ET.12 – Uncertainty mechanisms

December 2019

As a part of the NGET Business Plan Submission

nationalgrid

Executive summary

The energy industry is going through its biggest change in a generation and the associated uncertainty is considerable. Meeting the government's net-zero legislated target at lowest cost to consumers requires us to have a suite of mechanisms that deal with cost and volume uncertainty whilst allowing us to maintain the strong efficiency incentive of an ex-ante price control.

For the T2 period we propose 21 Uncertainty Mechanisms (*excluding financial indexation and cost pass-through*) associated with our business plan submission, as shown in table 1. Our proposals cover a cost uncertainty range across three areas relative to our baseline proposals (1) supply & demand uncertainty (*£729m- £1994m of associated cost uncertainty*); (2) whole systems uncertainty (*>£700m of associated cost uncertainty*); and (3) externally driven uncertainty (*>£750m of associated cost uncertainty*). In practise the cost uncertainty range could change once expenditure on in-period determinations which will only emerge in the T2 period are included.

Each of our proposals has been rigorously and robustly justified. We have extensively reviewed T1 period Uncertainty Mechanism performance, the uncertainty landscape for the T2 period, and feedback from our stakeholders. A comprehensive analytical framework, balancing complexity and cost reflectivity has been employed, using techniques such as regression analysis and Monte Carlo testing where we propose volume driver mechanisms to ensure the underlying Unit Cost Allowances are cost reflective.

This annex does not cover the cross-sector Uncertainty Mechanism for financial indexation and cost pass through. Full coverage of our proposals on these can be found in Chapter 15 "*How our plan should be financed*" of our submission, annex A14.14 "*RPEs and ongoing efficiency*", and annex A15.01 "*We can finance our plan*".

Table 1- Summary of our proposed Uncertainty Mechanisms for the T2 period

Area	Proposed UM			Adjusts allowances for …
Supply and demand uncertainty	Boundary capability	Volume drivers	Existing	changes in boundary capacity
	Generation connections		Existing	changes in generation connections
	Demand connections		Existing	changes in demand connections
	Facilitate competition (pre-consents)		New	delivery of contestable works consents
Whole systems uncertainty	System operability (voltage)		New	delivery of new shunt reactors
	Low voltage substation re-build		New	impact of embedded generation
	Protection and control	In-period determinations	New	needed protection and control upgrades
	Harmonic filters		New	delivery of filters for customers
	Whole systems coordinated adjustment mechanism		New	efficient whole system solutions
	System operability (other ESO requirements)		New	changes required by the ESO
Externally driven uncertainty	Physical security		Existing	changes in industry requirements
	Visual Impact Provision		Existing	delivering VIP projects when agreed
	Extreme weather		New	changes in requirements
	Operational Technology (OT) Cyber security		New	changes in cyber requirements (OT)
	Information Technology (IT) Cyber security		New	changes in cyber requirements (IT)
	Black start		New	changes in BEIS' requirements
	Ensuring a resilient network		New	new threats that arise
	SF_6 replacement programme		New	delivering SF_6 reduction investments
	Urban Improvement Provision		New	projects in disadvantaged urban areas
	Net Zero Provision		New	projects to deliver net-zero policy
	Innovation Plan		New	update our innovation programme

Contents

1.0 Introduction

In the May 2019 Sector Specific Consultation Ofgem indicated the continued need for Uncertainty Mechanisms (**UMs**) in an ex-ante price control*: "There is a forecast risk that we provide expenditure allowances that are higher or lower than they actually need to be. We use a range of uncertainty mechanisms to manage this risk."*

The transformation in the energy industry will increase the likelihood of customer needs changing in the T2 period, despite the shorter price control timeframe. This is likely to be further increased by the move towards whole system planning as a greater range of solutions become available through new processes like an expanded Network Options Assessment (**NOA**), being undertaken by the Electricity System Operator (**ESO**) and by further legislative and policy changes linked to delivering net-zero carbon emissions by 2050.

In line with Ofgem's guidance we have developed our baseline business plan to be consistent with the low-end of the industry's Common Energy Scenario. We believe that this provides a consistent, but conservative view of potential customer activities across the T2 period. Ofgem also require that we demonstrate how our plan can facilitate net-zero by 2050. UMs are the key tool through which our allowances can flex to meet this target.

UMs are not new for the T2 period. In the T1 period our load related UMs (*excluding the mid-period review*) have saved consumers £768m by automatically decreasing our allowances in response to evolving market conditions.

In preparing our T2 period plans, we have engaged with a range of stakeholders to discuss the causes and effects of uncertainty, the role UMs played in T1 period, and their views on our approach to managing uncertainty in the T2 period. This engagement showed strong support for the continued use of UMs, but a need to refine them to be fit for purpose. There was also support for the expansion of UMs, designed to manage uncertainty in areas of our plan where whole system options and competition provide opportunities to minimise the cost of the energy transition for consumers.

This annex contains details of our proposals for bespoke UMs in our business plan submission. These mechanisms are unique to National Grid Electricity Transmission (**NGET**), and therefore not set out within the May 2019 Sector Specific Methodology Decision (**SSMD**) but have been developed in parallel with extensive Ofgem and stakeholder engagement. This annex also contains our proposals for cross-sector mechanisms related to physical and cyber security, and whole systems coordination, proposed by Ofgem in the SSMD.

This annex does not cover the cross-sector UMs for financial indexation and cost pass through. Full coverage of our proposals on these can be found Chapter 15 "*How our plan should be financed*" of our submission, annex A14.14 "*RPEs and ongoing efficiency*", and annex A15.01 "*We can finance our plan*".

Uncertainty in the T2 period ranges across three areas:

1. **Supply and demand uncertainty** – changes to customers connecting to the system, and resulting wider flows across networks;
2. **Whole systems uncertainty** – uncertainty generated by maintaining the option to identify and deploy whole system alternatives to meet system requirements at lower cost to consumers
3. **Externally driven uncertainty** – uncertainty related to changes in legislation, policy or technological advances currently unknown and which may emerge during the T2 period

The types of mechanisms we propose to manage uncertainty across these three areas align with those proposed by Ofgem in the December 2018 Sector Specific Consultation:

1. **Volume drivers:** used when the volumes of activity that might be required is uncertain;
2. **In-period determinations:** used when the need and scope of projects is uncertain;
3. **Indexation:** used when the evolution of prices is uncertain; and
4. **Cost pass-through:** used for costs that are outside network company control

How Uncertainty Mechanisms covered by this annex work in practise

Volume drivers adjust our baseline allowance up and down by a Unit Cost Allowance (**UCA**) to ensure consumers only pay for what our customers need us to deliver. The adjustment is automatic, based on the actual volumes of pre-defined "output", such as the amount of new generation capacity connected to our network in each year of the price control. Volume drivers are used when there is relative cost certainty, but volume uncertainty exists.

In-period determinations require a separate funding application to be submitted, reviewed and approved by Ofgem before our baseline allowance is adjusted. This reduces the risk for consumers when there is uncertainty around both costs and volumes.

The proposals in this annex are underpinned by rigorous analysis and consideration of a range of alternative options. Throughout the development process we have constantly challenged ourselves to find a better way for consumers, customers and stakeholders. Inevitably this requires a trade-off to strike the right balance between design complexity and cost reflectiveness.

We have structured the main body of this annex into four sections:

1. What we have learned from the T1 period UMs to shape our T2 period proposals
2. The uncertainty landscape in the T2 period
3. Our approach to designing rigorous and comprehensive proposals
4. Our proposals on a page

Accompanying this, we are also supplying the following material:

A. **Three detailed appendices**, explaining our analytical framework, data sources and detailed justification of our proposals in line with Ofgem's Business Plan Guidance
B. **Excel workbooks** for four of our more complex volume driver UMs (*generation, demand, boundary capability, and system operability (voltage)*) which contain our full data set and a step-by-step guide to our analysis

2.0 What we have learned from the T1 period to shape our T2 period proposals

Chapter key messages	▪ The industry has changed significantly over the T1 period ▪ UCAs generally worked well, but haven't fully kept pace with change ▪ Our stakeholders have signalled UMs need to evolve for the T2 period

In the T1 period, we had 9 UMs, listed in table 2. All these UMs, except for DNO mitigation, have been used extensively. Additionally, we had a mid-period review in 2016/17 which provided the opportunity to examine specific aspects of our baseline allowance and propose adjustments to reflect updates to the environment in which we operate.

2.1 The industry has changed significantly over the T1 period

Conceptually UMs have worked well for consumers in the T1 period. Our load related UMs (*including the mid-period review*) have saved consumers £768m in response to evolving market conditions. Figure 1 highlights how allowances have adjusted for the three largest volume driver mechanisms (1) Generation connections; (2) Demand connections; and (3) Boundary capability.

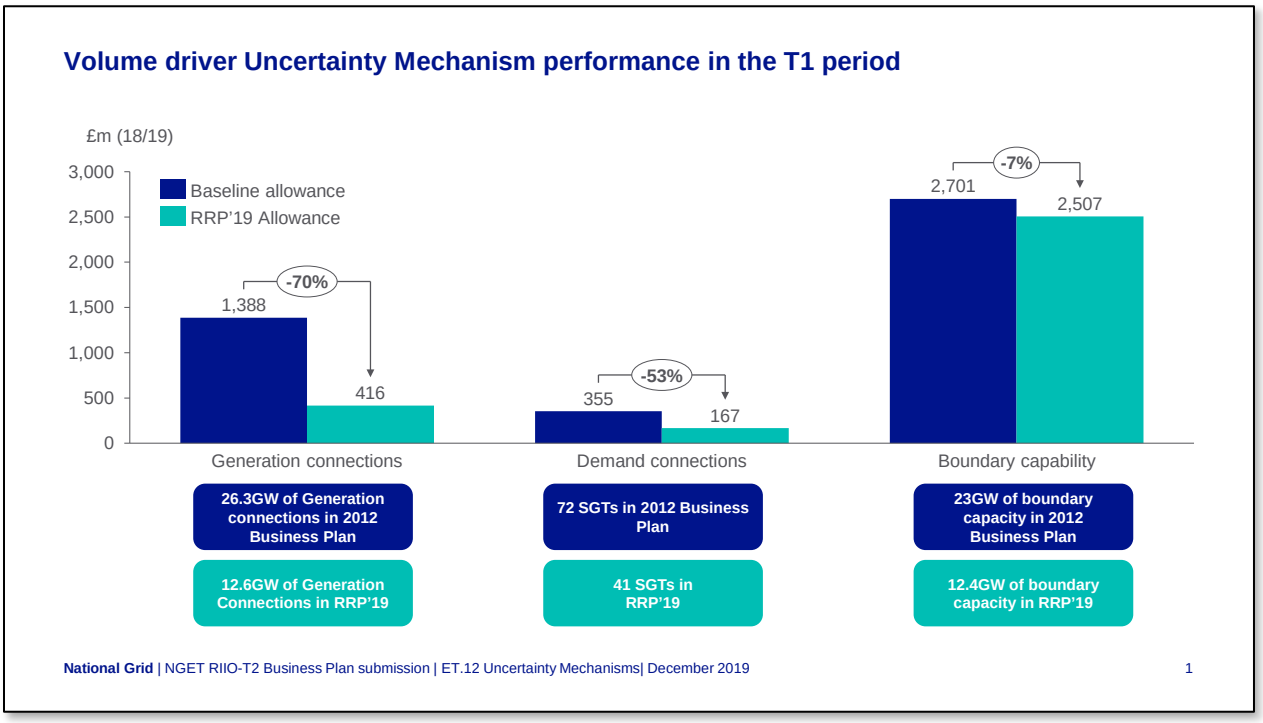
Table 2 – T1 period UMs

UM	Type	Description
Generation connections	Volume driver	▪ Baseline allowance, plus: ▪ £/kW allowance for a new connection ▪ £/km OHL allowance based on 2012 IET report
Demand connections		▪ Baseline allowance, plus: ▪ £/SGT allowance for a connection ▪ £/km OHL allowance based on 2012 IET report
Boundary capability		▪ Baseline allowance, plus: ▪ £/MW allowance specific to each boundary
DNO mitigation		▪ Baseline allowance, plus: ▪ £/unit specific to asst type
Embedded generation		▪ No baseline allowance ▪ £/kW allowance per new connection ▪ Only applicable in two zones (North East and Mid-Wales)

Undergrounding		▪ No baseline allowance ▪ £/km for cable undergrounding based on 2012 IET report ▪ Applicable all categories of work
Strategic wider works	In-period determination	▪ Baseline only for pre-construction works ▪ For wider works providing boundary capability over £500m ▪ Specific examination of need case and spend efficiency
Visual Impact Provision		▪ No baseline allowance ▪ Submissions to draw from a £500m shared allowance between network companies
Physical security		▪ No baseline allowance ▪ Two determinations, one 2015 and 2018 to reflect updated industry guidance

***OHL**: Overhead Line; **IET**: Institute of Engineering and Technology; **SGT**: Supper Grid Transformer*

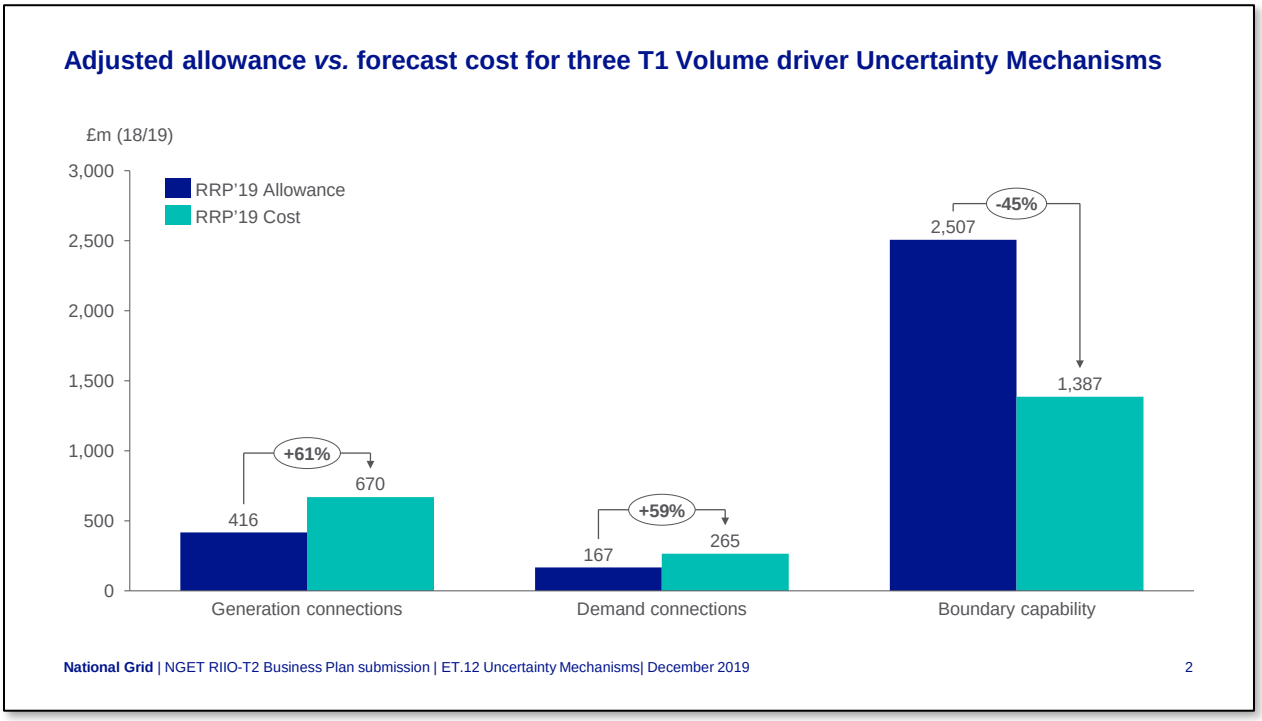
Figure 1 – T1 period allowance adjustment for the three largest volume driver UMs (*Regulatory Reporting Period (RRP) 2019*)



Allowances have been adjusted for **generation connections** as shown in figure 1, as some projects have delayed connection, such as offshore wind farms. Additionally, several nuclear

adjusted allowances compare to forecast costs for the three largest UMs from the T1 period: generation, demand and boundary capability.

Figure 2 – T1 period adjusted allowance vs. forecast cost for the three largest volume driver UMs (*Regulatory Reporting Period 2019*)



For **generation connections** the types of customer we are facilitating is changing. The volume of smaller connections requesting contracts has increased. Customers are creating a need to do enabling works which were less common before the T1 period, such as thermal enhancement of the existing circuits beyond substation works. We forecast our costs will be 61% higher than the adjusted allowance.

Demand connections also have new types of directly connected customers requesting connections, such as data centres. The simple design of UCA based on number of SGTs required for a DNO or network rail customer has led to a poor representation of actual costs as many connections with a scope other than a 'basic' transformer installation are being requested. This has meant that customers requiring new connection bays at existing infrastructure sites (*where no SGT is needed*) has not triggered funding through the UCA, even though spend for installation for the new bays is required. We forecast our costs will be 59% higher than the adjusted allowance. These types of connection requests are likely to become more common in the T2 period as the nature of DNO networks and customers change.

For **boundary capability** the background we are delivering against has changed since the start of the T1 period, with higher volumes of interconnection and embedded PV generation especially in southern England. This has meant that some reinforcements like reconductoring the Kemsley-Littlebrook and Fleet- Lovedean circuits, have delivered more capability than envisaged when the

T1 period UM was designed. We are also delivering innovative technologies like power flow controllers which give higher capability for lower cost, demonstrating the benefits of ex-ante allowances to deliver benefits. Allowances for each boundary were built by summing up the cost of works on the boundary required to meet the scenario used to set our T1 period baseline plan (*Gone Green*) and dividing by the capacity delivered. In many cases the allowance was built from a narrow set of works (*e.g. two projects per boundary in some cases*) and meant the UCA was not sufficiently cost reflective of the different types of investment that have subsequently been undertaken on some boundaries. Due to a combination of lower cost through innovation and a UCA that was insufficiently cost reflective we forecast our costs will be 45% lower than the adjusted allowance.

2.3 Our stakeholders have signalled UMs need to evolve in the T2 period

Understanding stakeholder needs and acting on their requirements has been central to our approach across our business plan submission. Our engagement approach on UMs has been proportionate, targeted predominately on stakeholders who are most impacted and interested in this aspect of our plan.

We published a consultation document in February 2019 supported by a webinar and other bespoke engagements (*e.g. through EnergyUK and bilaterally with DNOs*), where stakeholders told us it is appropriate to review existing UMs and consider the introduction of new ones, particularly where these facilitate potential whole system solutions.

Our **Independent Stakeholder Group** also challenged our approach to UMs and whether we are doing enough to ensure the price control is sufficiently flexible to allow net-zero 2050 targets to be met They also told us we could adopt a "*braver*" approach to addressing SF_6 leakage through innovation and leading by example to generate innovation in the supply chain. We were also challenged on whether our plans are doing enough to support system operability into the future. Feedback which was later echoed by both the **RIIO-2 Challenge Group** ("*we are particularly interested in your plans to support the ESO in its goal of carbon-free operation by 2025…*") and in the **ESO's direct feedback** on our July draft plan ("*keen to see you thinking more broadly around stability issues and what solutions you could provide*").

DNOs signalled through bilateral engagements they are keen to ensure the ability to identify and deliver whole systems solutions remained within the price control period and that UMs where a solution to facilitate this.

More broadly we have **engaged directly with consumers** on our plans in several areas. For example, when asked 60% of 1000 consumers surveyed said we should be net-zero by 2030 or 2040, ahead of the government target.

We have **engaged directly with Ofgem** and **Scottish Transmission Owners (TO)** across our full suite of proposed mechanisms through regular work group discussions, as part of the price control process, to ensure consistency across our submissions where relevant.

Finally, though the second half of 2019 we have undertaken detailed **bilateral engagement with Ofgem** to present our proposals, our underlying assumptions and analysis. Working versions of

the Excel workbooks for volume driver UMs were shared, accompanied by detailed explanatory slide packs. A session detailing our approach to designing volume driver UMs has also been held with a sub-set of our **Independent Stakeholder Group**, to address their challenges on this aspect of our business plan.

3.0 The uncertainty landscape in the T2 period

Chapter key messages	▪ Uncertainty in the energy sector is intensifying ▪ £729m- £1994m of TotEx uncertainty linked to supply and demand ▪ More than £700m of TotEx uncertainty linked to whole systems ▪ More than £750m of TotEx uncertainty linked to externally driven factors

The need for UMs that deal with cost and volume uncertainty in an ex-ante price control continues into the T2 period. Our T1 period experience and the views of stakeholders emphasises that the requirements from the network are changing rapidly and our UM designs need to keep pace. Despite the shorter price control period, uncertainty will intensify in the T2 period and it's therefore vital we bring forward proposals for UMs which are robust. It's also prudent we bring forward new UMs in areas not covered in the T1 period, but where uncertainty now exists.

3.1 Uncertainty in the energy sector is intensifying

Uncertainty in the T2 period ranges across three areas:

1. **Supply and demand uncertainty** – changes to customers connecting to the system, and resulting wider flows across networks;
2. **Whole systems uncertainty** – uncertainty generated by maintaining the option to identify and deploy whole system alternatives to meet system requirements at lower cost to consumers
3. **Externally driven uncertainty** – uncertainty related to changes in legislation, policy or technological advances currently unknown and which may emerge during the T2 period

Wider factors such as performance of the economy, political developments and technology innovation influence the uncertainty faced across all three areas. Table 3 summarises a non-exhaustive list of the underlying sources of uncertainty, which could change our investment requirements.

Table 3 – Underlying sources of uncertainty in the T2 period

Source of uncertainty in the T2 period
Net-zero policy directives (*including decarbonisation of transport and heat*)
Outcome of whole system assessments
Technology developments (*including digitisation*)
Brexit & other political uncertainty
Industry policy & codes developments (*including competition*)
Pace of decentralisation
Growth in the wider economy

In line with Ofgem's guidance we have developed our baseline business plan to be consistent with the low-end of the industry's Common Energy Scenario. We believe that this provides a consistent, but conservative view of potential customer activities across the T2 period.

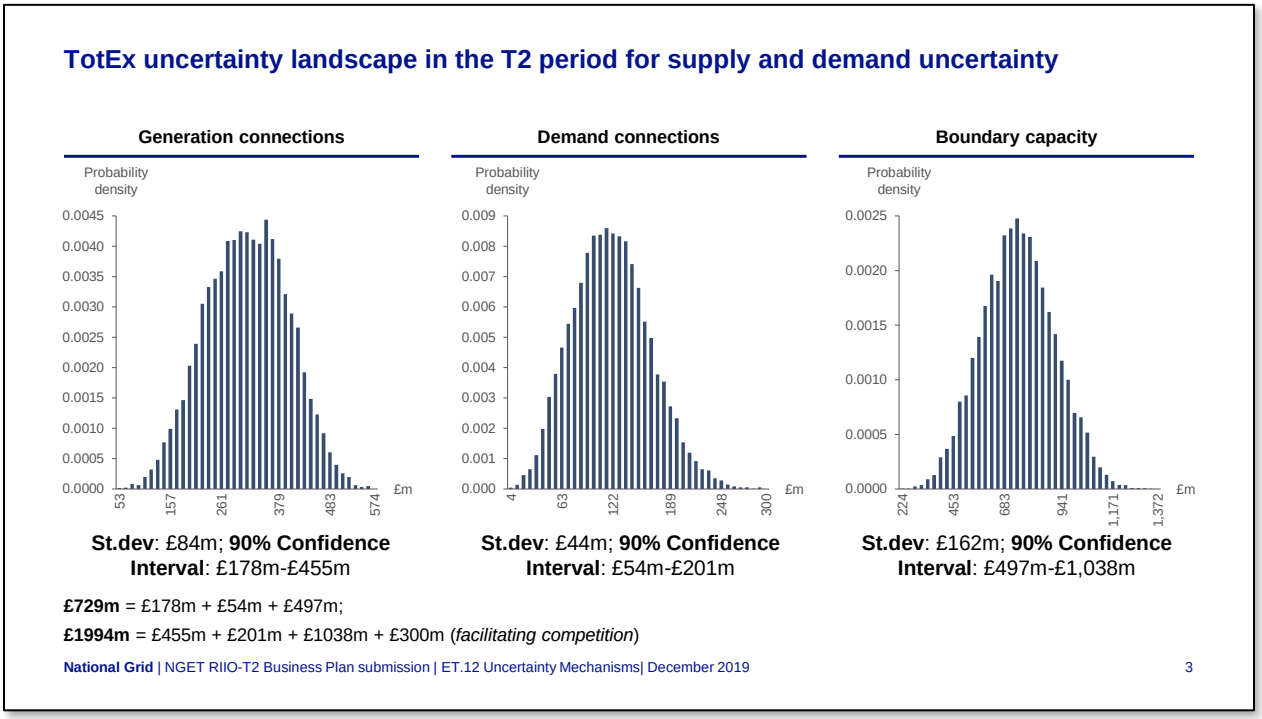
Our UMs are designed to allocate risk to whoever is best placed to manage it. For example, consumers can best manage uncertainty about the route to net zero emissions because the route will reflect changes in their behaviour. We are best placed to manage uncertainty over the costs of achieving the outputs consumers want.

3.1.1 £729m- £1994m cost uncertainty linked to supply and demand uncertainty

Our analysis indicates that changes to customer requirements of our transmission network in the T2 period drives a TotEx uncertainty range between £729m - £1994m, covering generation connections, demand connections and boundary capability. This is broken down in figure 3, using the outputs of our Monte Carlo analysis (*repeated random sampling of potential investments to meet system requirements to model the probability of different outcomes*).

Additionally, included within the £729m - £1994m range is spend for facilitating competition, i.e. achieving consents on large contestable projects (>£100m). This is not shown graphically in figure 3 given the limited number of projects which fall into this cost bracket but, we foresee this cost uncertainty range being >£300m, covering projects such as Eastern Link 3 and Torness-Lackenby reinforcement.

Figure 3 – TotEx uncertainty landscape in the T2 period for our three largest volume driver UMs



The range illustrated in figure 3 reflects a randomly selected (*repeated 10,000 times*) range of outcomes to deliver the baseline level of capacity, based on an underlying set of possible project costs.

Our set of project costs is extensive, associated with different types of works that we may deliver in the T2 period. These costs have been calculated through analysing system needs as signalled in publicly available data sources such as the ESO's Future Energy Scenarios (**FES**), the NOA, Electricity Ten Year Statement (**ETYS**) documents, the Transmission Entry Capacity (**TEC**) Register for generation connections, as well as our customer data for demand connections. We have also used historic T1 period project data to allow us to create a wide sample size.

Each data point has been rigorously checked to ensure consistency with data referenced in other parts of our submission, and with data held locally in National Grid. Where applicable we have cross-checked data with that held by the ESO, for example on boundary capabilities, for consistency.

To allow analysis to proceed it has been necessary to make some assumptions, for example on common data applicable to all mechanisms, and in some cases to omit data points from the underlying data set.

- On **boundary capability,** where we have chosen to not include projects >£100m in cost. This reflects guidance provided by Ofgem that projects >£100m are to potentially be considered as Large Onshore Transmission Investments (**LOTI**) and so subject to a specific assessment outside of our baseline ex-ante allowance;
- On **generation connections,** we have omitted T1 project costs data where the customer subsequently terminated their project (*for example Abernedd and Wylfa Newydd*);
- On **demand connections**, we have omitted a few high cost T1 project data points. For example, where underground tunnelling has been required, such as Islington and New Cross. The cost of underground tunnelling is a significant spend in projects and typically means they exceeds >£100m

As a result, the data used to create the ranges shown in figure 3 reflects the changing landscape we expect to deliver against for the T2 period, including 40% of generation customers contracted to connect in being less than 100MW, especially more batteries and gas reciprocating engines - incentivised by the capacity market. The data also reflects efficiencies from the T1 period such as higher volumes of power flow controllers (*a.k.a Smart wires*) in our boundary capability data set.

In building our proposal for other volume driver UMs, such as facilitating competition (pre-consents) and low voltage substation re-builds the available data set has been narrower. This is a reflection that these investments are less common in the T1 period, compared to areas such as generation and demand connections. Equally, the cost uncertainty range for the T2 period is anticipated to be narrower. We have therefore applied different analytical techniques to model proposed UCAs.

The accompanying Appendix A.2 (*Data & assumptions*) and Excel workbooks include a full list of the data points used in our analysis, the underlying data sources and relevant assumptions pertinent to the analysis including data points omitted, and a discussion on treatment of outliers.

To give more depth to our range in figure 3 we have calculated the standard deviation and the 90% confidence interval[1], see table 4. These represent the level of risks consumers and network companies would be exposed to in the absence of any UM. They also show how relatively conservative the baseline proposal is, which has been built from the projects we anticipate delivering against requirements for the low end of the Common Energy Scenario.

Table 4 – Risk metrics associated with supply and demand UMs in the T2 period

Uncertainty Mechanism	Standard deviation (£m)	90% cost uncertainty range (£m)	*Baseline proposal (£m)*
Generation connections	84	178 – 455	*216*
Demand connections	44	54 – 201	*89*
Boundary capability	162	497 – 1,038	*507*
Facilitating competition (pre-consents)		0 – 300	*182*

3.1.2 More than £700m of TotEx uncertainty linked to whole systems opportunities in T2 period

Uncertainty generated by excluding anticipated TotEx requirement from our baseline plans to allow whole system alternatives to be identified and delivered within the T2 period could exceed £700m.

Taking a whole systems approach to investing is something we have been doing extensively in the T1 period. Annex A7-8.03 'Whole Systems' provides deeper coverage of how we have developed a whole system plan and what more we recommend being done through setting this price control.

In several investment areas, such as managing increasing **fault levels from embedded generation**, **system operability**, **protection and control**, and **managing harmonic distortions** we firmly believe undertaking a whole system review of options prior to investing is in consumers' interests. The full extent of the investment required, and the party best placed to deliver will only emerge once a whole system review of options have been undertaken. When transmission investments are identified as being in consumers' interest, a UM that adjusts allowances and therefore gives us the flexibility to deliver these investments will be necessary.

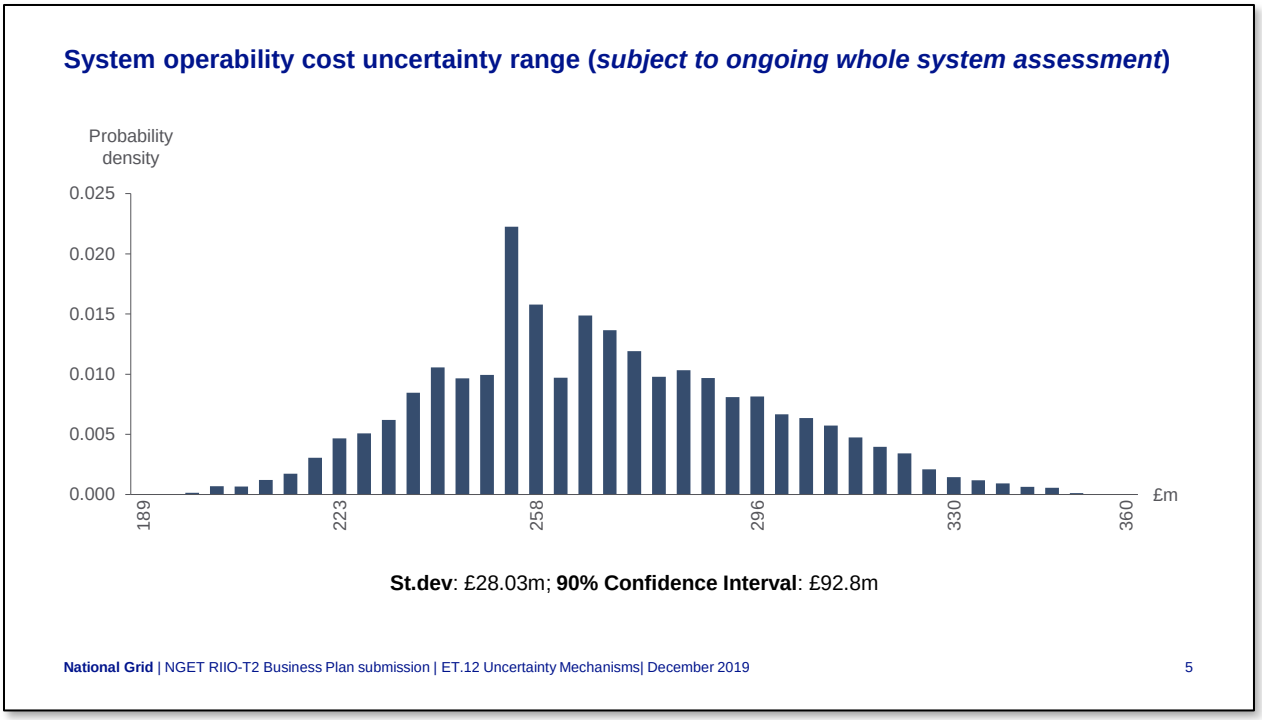
Fault levels exceeding the rating of substation assets presents a physical safety risk as well as a risk to security of supply. It's a growing issue, as the trend for more embedded generation on the system intensifies. Currently we work with DNOs and the ESO to determine if any non-build options can resolve anticipated fault level issues. This has included changes to running arrangements in either the transmission or distribution network. However, the scope to undertake non-build solutions is finite and replacing equipment that has reached its maximum capability with higher rated equipment may become increasingly necessary.

We are not proposing baseline spend for the T2 period for managing fault levels. Instead we feel continual whole system review within the T2 period and a UM are prudent tools to

[1] 90% of samples have a total cost between these two numbers

Through the Security and Quality of Supply Standards (**SQSS**) the obligation to manage network voltages sits with the TO in planning timescales. It's prudent therefore to quantify the cost uncertainty range if TO assets were the only option to manage static voltage issues. Figure 5 shows the outcome of our analysis. Taking account of our proposed baseline, our total cost uncertainty range is ~£289.4m[2]. To put figure 5 in more context, in the Common Energy Scenario 35 reactors would be required in the absence of other solutions. This rises to 45 in a Community Renewables scenario, which has significant levels of embedded generation and changes in consumer behaviour.

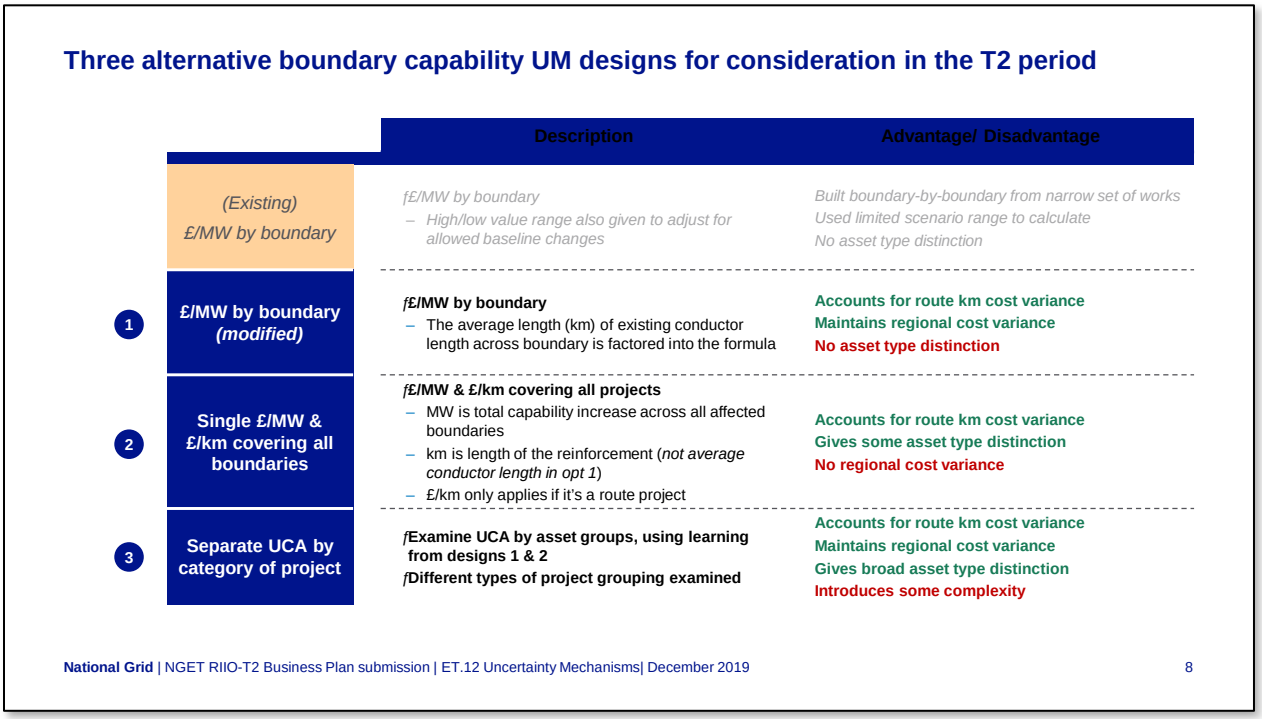
Figure 5 – System operability (voltage) cost uncertainty range (*subject to ongoing whole systems assessment*)



In direct response to stakeholder challenge through the enhanced engagement process **we are proposing a second System operability UM to provide allowances where an ESO whole system assessment of requirements (*other than voltage*) indicate a transmission network solution is best for consumers.** Examples of transmission assets that we may be required to deliver include synchronous condensers to manage system stability, and inter-trips where these represent a more economical alternative to transmission capacity. We are proposing an in-period determination in response to feedback from the ESO, the Independent Stakeholder Group and the RIIO-2 challenge group.

[2] £320.1m - £30.7m; where £320.1m is the 95% percentile and represents the upper bound of the 90% confidence interval shown in figure 5.

Figure 8 – Example of UM design considerations (Boundary capacity)



For **boundary capability**, we examined six different designs in detail (*two sub-sets of each design in figure 8*), after an initial consideration of over 27 at a conceptual level. The designs test the influence on costs of factors like geographic location by including boundary lengths; and whether creating separate UCA values for route (*i.e. projects with an associated length like reconducting*) and non-route projects helped to better explain the cost to output relationship.

Similar detailed consideration of cost drivers was examined for generation and demand connection UM designs. For example, with **generation connections** we looked at seven different designs (*including continuing the T1 period model*) including whether a clearer relationship exists when projects were grouped as either connecting at a new or existing substation; and if substation design had a bearing on the relationship by splitting projects into those which are Air Insulated Substations (**AIS**) *vs.* Gas Insulated Substations (**GIS**). For **demand connections** seven designs (*including continuing the T1 period model*) were examined including whether a substation being defined as an infrastructure *vs.* connections site had a bearing on the cost to output relationship.

Appendix A.3 (*Specific proposal detail*) of this annex has a full list of all the alternate designs considered by UM and our associated Excel workbooks provide a deeper commentary on the designs cost drivers, for the generation, demand, boundary capability and system operability (*voltage*) UMs.

Whilst more detailed designs can sometimes be more complex, they are often more accurate (*cost reflective*). To measure this trade-off, we used analytical techniques to model each design and assess the additional benefits.

undergrounding allowance and replacing this with a cable expansion factor. The main benefit of expansion factors over the approach used in the T1 period is that they allow cable projects and the lengths of existing cable circuits to feature in the regression analysis, without having to make ex-post adjustment. This is useful when factoring in the length of existing circuits crossing a boundary.

All models except for Model A and C significantly improve the mean difference between cost and allowance in comparison to the T1 period approach. The mean residual is over £120m if the T1 period method is followed; whereas it drops to below £10m if Models B, D, E, or F are selected. Standard deviation of the residual across a range of future scenarios is also lower in these four models; with the lowest standard deviation offered by Model F.

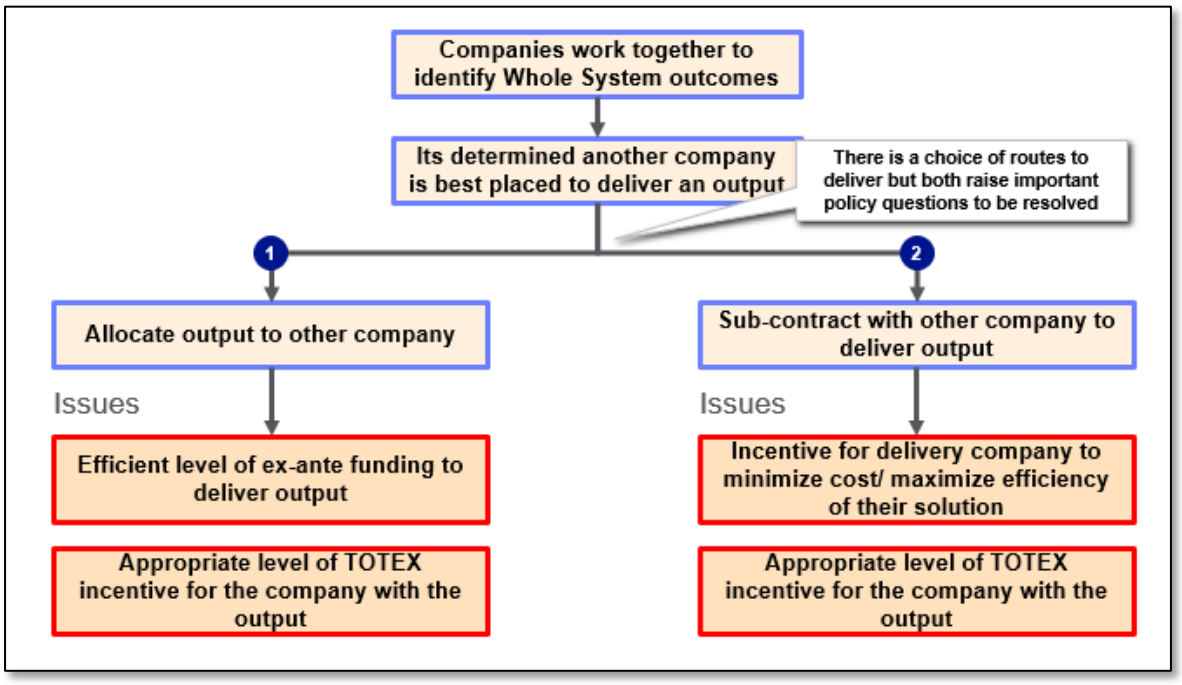
Since the means of Models B, D, E, and F are all close together, we prefer the model with the lowest standard deviation, Model F. This means the design has a near equal probability of costs being greater or less than allowance and the risk to consumers of large fluctuations is minimised.

Risk & ownership	Materiality & freq. of use	Drawbacks & mitigations
System need and best whole system solution uncertain. Requirements driven by annual ESO NOA process. Network company manages cost risk, whilst consumer best to manage volume risk.	Possibly annually, at least biennial with near 100% probability of some future requirement.	Minor increases in complexity of mechanism outweighed by significant increase in cost-reflectivity and mitigated through simplifications in other areas, such as approach to cable costs.

Business Plan Data Table treatment

No uncertain costs included in the baseline plan; UM snapshot table (NGET_ET_12A_Uncertainty Mechanisms Snapshot table) and bespoke uncertainty tables (Table D.5.18) include our proposals.

Figure 13 - Approach to reconciling a whole system solution delivered by one network company for another



The Coordinated Adjustment Mechanism is likely to be best suited to route (1), although we note that further detail will be required on how funding levels at the respective companies will be adjusted and the setting of the appropriate level of TotEx incentive for the company with the output.

Risk & ownership	Materiality & freq. of use	Drawbacks & mitigations
Network company manages cost risk, whilst consumer best to manage volume risk.	Possibly annually, with near 100% probability of some future requirement.	Implementation may require further updates to system codes. The mechanism will also require agreement with the DNOs who lag the TOs in timing of price controls. We will continue to work with Ofgem and industry in parallel to our price control submission to implement.

Business Plan Data Table treatment

No uncertain costs included in the baseline plan; UM snapshot table (NGET_ET_12A_Uncertainty Mechanisms Snapshot table) and bespoke uncertainty tables (Table D.5.18) include our proposals.

UM7-6 Harmonic coordination	Chapter reference: 7	In-period determination
Proposal summary	▪ An in-period determination to allow NGET to coordinate harmonic design, and build cheaper harmonic filters following agreement with our customers ▪ For the T2 NGET-led approach would require expenditure between £60m-£100m	

Alternative options examined

- Including within the baseline proposal

Data & assumptions

- For the period up to 2030, a customer-led approach would require approximately [redacted] harmonic filters to be installed, at an estimated whole life cost of £146m
- A TO led approach would require [redacted] filters to be installed (i.e. fewer units), at an estimated whole life cost of £119m. This would be a consumer saving of £27m (18%)
- For the T2 period the TO expenditure is between £60m-£100m

Triggers of use

- Signed Bilateral Connection Agreement with customer

Narrative commentary

Customers are currently required to install harmonic filters to comply with voltage levels set in the Grid Code (a customer-led approach). Uncontrolled harmonics in the power system can have negative effects such as overheating of generators, motors, transformers, cables and capacitors, maloperation of protection equipment and circuit breakers, metering giving false readings, and interference with telecommunications and signalling systems. Harmonics can lead to reduced equipment life. Operationally, they can lead to inadvertent tripping of equipment.

The Grid Code places an obligation on transmission network owners to ensure that harmonic levels on the network are managed and kept below 'acceptable' levels as defined in Engineering Recommendation G5/4. In turn, network owners discharge this obligation by imposing harmonic limits on individual customers whose equipment creates harmonics. Customers are required to comply and stay within harmonic limits issued to them by network owners and consider ways to reduce or mitigate if they can't stay within the limits. Mitigation is usually achieved by installing harmonic filters.

The management of harmonics is an industry wide issue, as it is primarily driven by low carbon, electronic-based technologies such as solar PV, battery connections, EV charging, wind, HVDC connections etc. The proposal for TOs to take greater responsibility for installation and ownership of harmonic filters has been developed with other network owner customer support.

Once this is sufficiently advanced, we believe funding for harmonic filters should be managed via a price control in-period determination.

Risk & ownership	Materiality & freq. of use	Drawbacks & mitigations
Customer need and timing of implementation uncertain. Requirements driven by volume of generation connected through power electronics (predominately renewables). Cost and volume risk too high to set ex-ante allowances to protect consumers.	Low frequency over T2 period (2 or 3 maximum anticipated). High probability of usage, subject to any necessary code changes being implemented.	Additional regulatory burden of in period determination outweighed by the consumer benefits Further mitigated by grouping of relevant customer projects informed by outcome of CfD rounds.

Business Plan Data Table treatment

No uncertain costs included in the baseline plan; UM snapshot table (NGET_ET_12A_Uncertainty Mechanisms Snapshot table) and bespoke uncertainty tables (Table D.5.18) include our proposals.

UM7-7 System operability (other ESO requirements)	Chapter reference: 7	In-period determination

Proposal summary	▪ An in-period determination, to provide allowances where an ESO whole system assessment (*or other ESO assessment)* of system operability requirements (*other than voltage*), indicate a transmission network solution is best for consumers ▪ Where the ESO's assessment determines a requirement for transmission-based system stability solution, e.g. a Synchronous Condenser we propose an in-period determination ▪ In-period determinations following ESO trigger of TO solution to manage System operability issues for investments >£20m ▪ Automatic allowance adjustment and logging up for investments <£20m

Alternative options examined

N/A

Data & assumptions

N/A

Triggers of use

- Completion of an ESO led whole system assessment (*or other ESO process*)

Narrative commentary

The energy system is transitioning to one with increased volumes of non-synchronous generation and in April 2019 the ESO announced its ambition to be able to fully operate the electricity system with zero carbon by 2025.

We believe that network companies have a vital role to play, alongside traditional 'market' players in ensuring the ESO has the systems, services and products needed to minimise the cost of the transition for consumers. This can only occur if we have a flexible price control to deliver the required investment.

The ESO's System Operability Framework points to a range of system operability challenges, such as lower system inertia. TOs have already been delivering solutions in collaboration with the ESO to provide solutions to issues, such as Scottish Power Transmission's Project Phoenix (https://www.spenergynetworks.co.uk/pages/phoenix.aspx) to install a Hybrid-Synchronous Condenser on their network. Further, the ESO have instigated several NOA Pathfinder projects across the country to look for optimal solutions to a range of issues.

We believe it's prudent that we can bring forward solutions to operability challenges during the T2 period as inputs to the ESO's whole system assessments on a range of issues. The solutions likely to be required include, synchronous compensators to manage system stability issues, additional circuit breakers on the network to reduce system operational costs and inter-trips. If no funding mechanism is in place, we will not be able to deliver solutions that minimise cost.

Providing the ability to have an in-period determination means:

- Reduced system operation costs as the ESO
- Maintaining a reliable electricity supply – ensuring that protection and control systems work and the ESO can continue to operate the network in a safe and reliable manner
- Enabling net-zero by 2050 by allowing more renewables to connect to the system and displace conventional generation by not having any running restrictions

Where the ESO's assessment determines a requirement for transmission-based system stability solution, e.g. a Synchronous Condenser we propose an in-period determination. For all other ESO triggered solutions, e.g. inter-trips and additional circuit breakers we propose the TO be allowed to automatically increase revenue upon clear signal from the ESO. Revenue increases beyond £20m linked to this UM over the course of the T2 period would be subject to an in-period determination.

Risk & ownership	Materiality & freq. of use	Drawbacks & mitigations
Volume of TO solutions to future operability challenges unclear prior to ESO whole system assessment. Risk too high to set ex-ante allowances.	High frequency for small requirements (*e.g. inter-trips*) Low frequency for large requirements (*e.g. synch. Comp.*) Very high probability of usage (*based on ESO's System Operability Framework*)	Depending on how ESO requirements evolve over the T2 period, the frequency of usage for this mechanism could be quite high We propose to mitigate this through the introduction of a logging up mechanism for smaller requirements that the ESO has tested as economic.

Business Plan Data Table treatment

No uncertain costs included in the baseline plan; UM snapshot table (NGET_ET_12A_Uncertainty Mechanisms Snapshot table) and bespoke uncertainty tables (Table D.5.18) include our proposals.

UM10-1 Extreme weather	Chapter reference: 10	In-period determination
Proposal summary	▪ One in-period determination within the T2 period, mid-way ▪ Account for changes to Engineering Technical Report (**ETR138**) guidance on flooding, and/ or direction from BEIS to protect sites from flooding ▪ Common in-period determination for all network companies following ETR138 guidance	

Alternative options examined

N/A

Data & assumptions

- No current view of cost associated with this uncertainty within T2 period

Triggers of use

- Changes to requirements for flood protection under ETR138 and/or direction from BEIS

Narrative commentary

Whilst flood risk does not tend to change significantly within short amounts of time, the recommended resilience against flooding has changed over T1 period requiring additional expenditure in this area. BEIS and industry regularly review ETR138 guidance and appropriateness. Whilst probability of using this reopener is low, having a UM would allow for flexibility in plans to adapt to latest threat guidance changes.

Risk & ownership	Materiality & freq. of use	Drawbacks & mitigations
Neither network company nor consumer best placed to manage uncertainty.	One determination mid-way through the T2 period.	If threat levels rapidly change, it can result in expenditure on assets prior to triggering allowance. We will continue engagement with the relevant bodies to minimise this risk.

Business Plan Data Table treatment

No uncertain costs included in the baseline plan; UM snapshot table (NGET_ET_12A_Uncertainty Mechanisms Snapshot table) and bespoke uncertainty tables (Table D.5.18) include our proposals.

UM10-4 OT Cyber Security	Chapter reference: 10	In-period determination
Proposal summary	▪ Two in-period determinations within the T2 period, mid-way, and at the end ▪ These plans would cover changing threat levels and available solutions ▪ Our expected uncertainty is approximately £[redacted]m	

Alternative options examined

- Ofgem confirmed proposal for an in-period determination in T2 period

Data & assumptions

- **Data** – our estimate value of uncertainty has been calculated based on current expected expenditure for projects. This estimate is subject to change following delivery of T1 period investments and continued assessment of cyber threats, risks and available solutions

- **Assumptions** – Our main assumption for the T2 period is that Ofgem accept that flexibility is required for our cyber plans. We expect the cyber threat to change ahead of and throughout the T2 period and therefore we must be flexible in our approach to addressing cyber risk. As well as changes to cyber threats, new solutions will become available as technology matures. By taking advantage of new solutions, we will be able to better protect from cyber threats in the future

Triggers of use

- Changes to cyber threat, formal requirements, available solutions and capabilities

Narrative commentary

Cyber threats are constantly changing and the threat to Operational Technology is quickly advancing. We are responding, however expect these threats to change within the T2 period. As the landscape changes, solutions and capabilities also get more advanced and therefore may be more appropriate in the future. Allowing flexibility in our plans lets us address threats as they arise and allows us to take advantage of new solutions that may not have been previously available.

We understand that it may be Ofgem's intention only to allow the first in-period determination for OT if network companies chose not to submit their business plans in December 2019. Given the evolving landscape on OT, we have provided a proposal for investments in which we have high confidence in scope, cost and deliverability with a view of required projects for which we are not currently seeking allowances.

The work we are completing to enhance OT cyber resilience within the T1 period will enable us to be in a more informed position at the first T2 period in-period determination opportunity to request allowances. We therefore request that Ofgem allow network companies that have provided business plans in December 2019 to have use of the first in-period determination in T2 period.

We commit to ongoing engagement with the NIS Competent Authority informing Ofgem's decision of our proposed adjustment to allowances within T2 period.

Risk & ownership	Materiality & freq. of use	Drawbacks & mitigations
Neither network company nor consumer best placed to manage uncertainty.	Two determinations currently proposed. Current estimate of materiality is £[redacted]m.	If threat levels rapidly change, it can result in expenditure on assets prior to allowance being triggered. We will continue engagement with the relevant bodies to minimise this risk.

Business Plan Data Table treatment

No uncertain costs included in the baseline plan; UM snapshot table (NGET_ET_12A_Uncertainty Mechanisms Snapshot table) and bespoke uncertainty tables (Table D.5.18) include our proposals.

UM10-3 IT Cyber Security	Chapter reference: 10	In-period determination
Proposal summary	▪ Two in-period determinations within the T2 period, mid-way, and at the end ▪ These plans would cover changing threat levels and available solutions ▪ Our expected uncertainty included within our plans is approximately £[redacted]m	

Alternative options examined

- Ofgem confirmed proposal for an in-period determination in T2 period (*aligned to those allowed for OT Cyber Security*)

Data & assumptions

- **Data** – our estimate value of uncertainty has been calculated based on current expected expenditure for projects. This estimate is subject to change following delivery of T1 period investments and continued assessment of cyber threats, risks and available solutions
- **Assumptions** – Our main assumption for the T2 period is that Ofgem accept that flexibility is required for our cyber plans. We expect the cyber threat to change ahead of and throughout the T2 period and therefore we must be flexible in our approach to addressing cyber risk. As well as changes to cyber threats, new solutions will become available as the landscape matures. By taking advantage of new solutions, we will be able to better protect from cyber threats in the future

Triggers of use

- Changes to cyber threat, formal requirements, available solutions and capabilities

Narrative commentary

Cyber threats are constantly changing and the threat to Operational Technology is quickly advancing. We are responding, however expect these threats to change within the T2 period. As the landscape changes, solutions and capabilities also get more advanced and therefore may be more appropriate in the future. Allowing flexibility in our plans lets us address threats as they arise and allows us to take advantage of new solutions that may not have been previously available.

Within their Sector Specific Methodology Decision, Ofgem stated that there would be two in-period determinations for works included within the Cyber Resilience Plan (*for OT works*) and one in-period determination for works included within the Business IT Security Plan (*for IT works*). The threats we face are constantly evolving and our IT systems can provide a gateway to our OT systems. For this reason, we consider it appropriate and would request Ofgem to also allow for a second in-period determination for the uncertainty within our Business IT Security Plan in T2 period.

We commit to ongoing engagement with the NIS Competent Authority informing Ofgem's decision of our proposed adjustment to allowances within the T2 period.

Risk & ownership	Materiality & freq. of use	Drawbacks & mitigations
Neither network company nor consumer best placed to manage uncertainty.	Two determinations currently proposed. Current estimate of materiality is £[redacted]m.	If threat levels rapidly change, it can result in expenditure on assets prior to allowance being triggered. We will continue engagement with the relevant bodies to minimise this risk.

Business Plan Data Table treatment

No uncertain costs included in the baseline plan; UM snapshot table (NGET_ET_12A_Uncertainty Mechanisms Snapshot table) and bespoke uncertainty tables (Table D.5.18) include our proposals.

UM10-5 Black Start	Chapter reference: 10	In-period determination
Proposal summary	▪ One determination proposed in T2 period to update our plans to implementation the new Black Start standard currently under review by BEIS ▪ Common determination available for all network companies required to meet BEIS Black Start standard	

Alternative options examined

N/A

Data & assumptions

- No current view of cost uncertainty

Triggers of use

- Updated Black Start standard proposed by BEIS

Narrative commentary

BEIS are currently in the process of proposing a new standard for restoration times in the event of a Black Start scenario. To meet this standard NGET and other network companies would need to ensure that they can facilitate required restoration times and therefore invest in asset quality and capabilities.

We support the introduction of this standard, which has been reviewed by the Black Start Task Group. We propose the use of an in-period determination to account for the changes required to our plan because of the standard being implemented.

The benefit of allowing this flexibility to our plans would be that we can help to ensure achievement of BEIS's Black Start standard, facilitating faster restoration times in the event of a Black Start scenario.

Risk & ownership	Materiality & freq. of use	Drawbacks & mitigations
Neither network company nor consumer best placed to manage uncertainty.	One in-period determination to adjust allowances	If risk levels rapidly change, it can result in expenditure on assets prior to triggering an allowance. We will continue engagement with the relevant bodies to minimise this risk.

Business Plan Data Table treatment

No uncertain costs included in the baseline plan; UM snapshot table (NGET_ET_12A_Uncertainty Mechanisms Snapshot table) and bespoke uncertainty tables (Table D.5.18) include our proposals.

UM11-1 SF_6 replacement programme	Chapter reference: 11	In-period determination
Proposal summary	▪ Allow for investment needed for SF_6 reduction	

Alternative options examined

- No SF_6 reduction investment programme in the T2 period
- Baseline funding for an SF_6 reduction investment programme

Data & assumptions

- We carried out an extensive review of our SF_6 assets and options for replacing them

Triggers of use

- To be developed

Narrative commentary

The UK's net zero by 2050 ambition became law in the UK in June 2019, which we fully support. SF_6 is our largest controllable greenhouse gas contributor and we recognise that achieving net zero needs a step change to how we manage our SF_6 equipment.

We are considering a mechanism to give flexibility to:

1) Respond to changing leaks within T2 period;
2) Assess the best intervention for the asset and leak and;
3) Stretch beyond the Science Based Target (SBT) Net Zero pathway.

This uncertainty mechanism will fund us to make reductions in SF_6 emissions with the long-term aim for continued and permanent reduction that our stakeholders expect to see from us.

Our stakeholders are clear that they want us to be carbon neutral faster than the 2050 target. During our consumer research testing 60% of consumers wanted us to be a net zero business by 2030 or 2040, instead of 2050. In line with our stakeholders, we believe it is the right thing to do, whilst ensuring the right levels of speed and cost are fully acceptable to consumers. Additionally, Ofgem asked that we provide information on what is needed to remove SF_6 from our system and whether it is carbon price sensitive. These investments are carbon price sensitive and the cost of carbon doesn't currently cover the investments required for this mechanism, which focuses on longer-term benefits.

Our considered for a mechanism has two levels of operation:

1) For reductions in SF_6 emissions up to our SBT net zero pathway in the T2 period, we're considering an approach that will build a value of SF_6 leakage reduction (or prevented) in £/(kg.yr). Our October proposal outlined a value of £150m to replace some of the worst leaking and simple Gas Insulated Busbar (GIB) assets on the system. Our considered approach would use a portfolio of solutions (repairs and replacement) using an annualised equivalent costing (AEC) which assesses the remaining life of the leaking assets to make the best decision for the installation, for example a repair to align with substation replacement. For level 1, the uncertainty mechanism funding in £/kg.year would be based on the value delivered and expected period of effectiveness (life of the intervention). This rate will need to be defined through engagement with Ofgem ahead of commencing the T2 period

2) For reductions in SF_6 emissions beyond the SBT net zero pathway in the T2 period, we think an extension to the level 1 approach could be suitable. The level 2 part of the uncertainty mechanism recognises the step change in performance required to respond to evolving environmental ambitions and allows us to go beyond the SBT net zero pathway for this period (-34% emissions by 2026). Level 2 could work in the same way as level 1 but with a re-calibrated for the funding rate in £/(kg.yr), because in level 1 the simplest assets with the highest leak rate will have already been targeted. Thus, the remaining assets will be more complex,

and the volumes of leaks will be smaller, requiring us to spend more to get the same benefit. We expect increments within level 2 meaning a non-linear approach would be required

The assets we are targeting with this UM in both levels aren't prioritised by existing processes, so there is limited overlap with our existing NARMs plans but they are complimentary to each other. We will engage with Ofgem and consumers to fully develop this approach over the coming months, aiming to have both parts of the mechanism in place for the start of the T2 period in 2021.

Risk & ownership	Materiality & freq. of use	Drawbacks & mitigations
The considered option allows to reflect the latest carbon price or requirements from stakeholders. We are best placed to manage this risk by developing a mechanism before the start of T2 period which does this.	We propose this determination would throughout the T2 period.	The net zero target is relatively recent. This UM allows us to develop a mechanism as details become clear.

Business Plan Data Table treatment

No uncertain costs included in the baseline plan; UM snapshot table (NGET_ET_12A_Uncertainty Mechanisms Snapshot table) and bespoke uncertainty tables (Table D.5.18) include our proposals.

UM11-2 Visual Impact Provision	Chapter reference: 11	In-period determination
Proposal summary	▪ An in-period determination to allow for the investment needed to take forward VIP projects once we have fully developed our proposals and Ofgem has reviewed them	

Alternative options examined

- Baseline funding for our VIP projects.
- A true-up mechanism at the end of the T2 period

Data & assumptions

- We reviewed our experience with VIP projects in the T1 period, including the extent of stakeholder engagement and development time needed to produce firm proposals

Triggers of use

- The trigger for this UM is Ofgem approving the efficient costs of VIP projects that we have submitted

Narrative commentary

We have an established assessment methodology for VIP project priorities, created by an independent landscape specialist, which we have consulted on and which Ofgem has approved. There is strong support from local stakeholder groups to take forward VIP projects. With respect to VIP costs, most bill payers (66%) find it acceptable for the cost of VIP to be socialised via household bills.

We considered alternative such as baseline funding for our VIP projects. However, our experience with VIP projects in the T1 period is that we need to carry out extensive stakeholder engagement and development work to produce firm proposals that we can submit to Ofgem for approval. As a result, there can be long time lags between proposing a project and receiving funding approval. Ofgem assesses the efficient costs of VIP projects when we propose them, so an in-period determination appears to be a better approach than baseline funding.

We also considered a possible true-up mechanism at the end of the T2 period. However, this would involve us having to start projects without funding in place and with some uncertainty over when and what amount of funding we would receive. This would to slow down VIP projects which is not in the best interests of consumers.

Risk & ownership	Materiality & freq. of use	Drawbacks & mitigations
We develop our VIP schemes in close collaboration with stakeholders and Ofgem assesses the efficient	We propose this in-period determination would apply in the T2 period for each VIP scheme that we submit and which Ofgem approves	In-period determinations can create uncertainty, but there are clear and established rules around how VIP scheme are assessed and funded

Business Plan Data Table treatment

No uncertain costs included in the baseline plan; UM snapshot table (NGET_ET_12A_Uncertainty Mechanisms Snapshot table) and bespoke uncertainty tables (Table D.5.18) include our proposals.

UM11-4 Net zero	Chapter reference: 11	In-period determination
Proposal summary	▪ In-period determination to allow for any investment needed in response to potential new requirements to achieve the UK's target of net-zero greenhouse gas emissions by 2050	

Alternative options examined

- **No net-zero in-period determination and no baseline funding**. We dismissed this option on the basis that the UK target of net-zero greenhouse gases by 2050 was only passed into law in June 2019 and there might be new requirements for energy network companies in the T2 period as the government develops it policy to achieve the target in more detail

- **No net-zero reopener, but baseline funding for a net-zero investment programme**. We are required to build our business plan based on the low end of the Common Energy Scenario and its assumptions about generation and demand. The scenario does not assume a reduction in greenhouse gases large enough to deliver against the UK's commitment to net zero by 2050. As a result, we could not include investment for a net-zero investment programme in our baseline. We also consider that the pathway to net-zero is currently too uncertain for us to be able to propose a full net-zero investment programme at this stage

Data & assumptions

We have made the following assumptions:

- There might be new requirements for energy network companies in the T2 period as the government develops it policy in more detail to achieve the net-zero bv 2050 target
- Given the need for rapid action to tackle climate change we do not think it is feasible to wait for the T3 period to start implementing any new net-zero requirements

Triggers of use

- A new requirement from the government or a governmental body in relation to achieving the UK's target of net-zero greenhouse gas emissions by 2050

Narrative commentary

The UK's commitment to achieve net-zero greenhouse gas emissions by 2050 was passed into law in June 2019.

Our business plan covers a crucial period when we all expect rapid change in the energy system to dramatically reduce carbon emissions to achieve the UK's net-zero by 2050 target. Our plan highlights specific opportunities within the regulatory framework, to enable and accelerate the UK's progress to net zero. We are putting forward collaborative, innovative, and whole-system solutions to support policymakers. We are reinforcing this with commitments to reduce our own emissions to deliver the UK's net-zero target and ensure no one is left behind in the energy transition.

There could be new net-zero requirements on energy network companies in the T2 period because the UK's target was only put into law in June 2019 and there remains a lot of uncertainty in government and the energy sector about the best pathway to achieve it. As the UK government starts to define its policy for low-carbon energy, heating and transport (and other sectors) in more detail there might be new requirements for energy network companies. This UM would allow for the investment that is required to happen more quickly.

We are proposing anticipatory options to help achieve the net-zero target, such as a rapid electric vehicle charging network at motorway service areas and reducing connection costs for off-shore wind generators. Projects such as these will need funding and our net-zero UM could provide a route to release these funds.

Risk & ownership	Materiality & freq. of use	Drawbacks & mitigations
The in-period determination deals with the risk that new net-zero	We propose this in-period determination would apply twice	Re-opening the price review can create uncertainty, but we are